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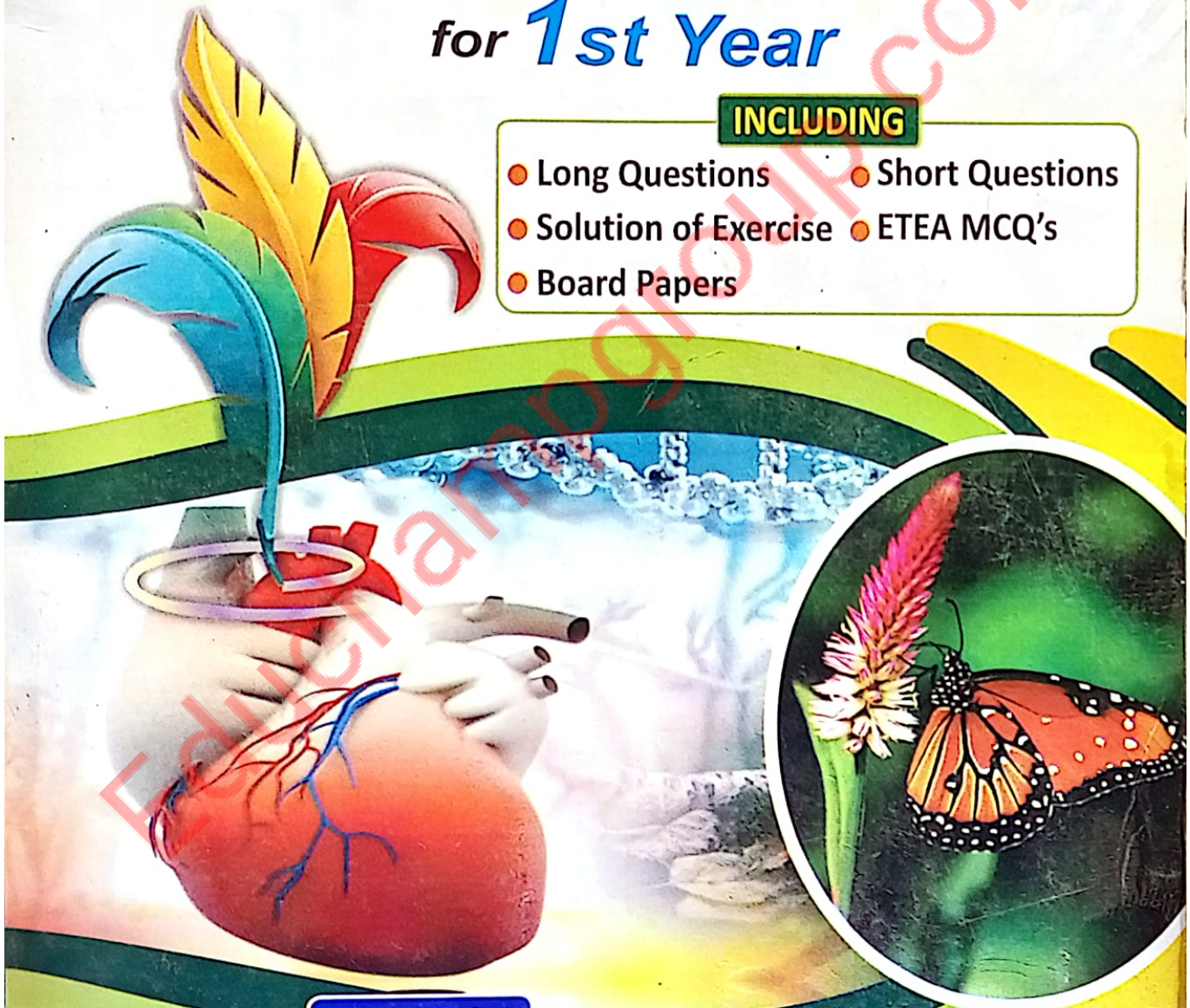
Comprehensive Notes

BIOLOGY

for 1st Year

INCLUDING

- Long Questions
- Short Questions
- Solution of Exercise
- ETEA MCQ's
- Board Papers



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CHAPTER

1 CELL STRUCTURE & FUNCTION

In this chapter we will study:

- Introduction to cell
- Techniques used in cell biology
- Cell wall and plasma membrane
- Cytoplast and cell organelles
- Prokaryotes and eukaryotes

Cell:

Cell is derived from a Latin word *cellula* which means small apartment or room.

Definition:

- It is the basic unit of structure and function of living organisms.
- Cell is the structural unit means that cell form the structure of an organ.
- Cell is the functional unit means that cell performs various functions of the body.
- Cell is the smallest unit of life which can carry all the activities of life.

Unicellular Organism: ***(Uni-One)***

- Those organisms which consist of only one cell are called unicellular organism.
- Their one cell can carry all the activities of life such as reproduction, respiration, digestion and excretion etc. e.g., bacteria, amoeba etc.

Multicellular Organism: *(Multi-Many)*

- Those organisms which are composed of more than one cell are called multicellular organisms.

Discovery of Cell:

- Cell was discovered by an English microscopist Robert Hook in 1665.

Cell Theory:

- Cell theory was put forward by two German scientists Mathias Schledon (1838) and Theodar Schwann (1839).
- Sheldon was a botanist and Schwann was a zoologist.

Main Points:

- All living organisms are composed of one or more cells.
- Cell contains heredity material which passes from parents to offsprings.
- New cells arise from pre-existing cells by cell division.
- All metabolic process takes place within cells.

Techniques used in Cell Biology:

Microscopy:

- The use of microscope to study microorganisms, cells and its components is called microscopy.
- It makes a very valuable contribution to our understanding of cell.

Microscope: *(Micro-small, scope-to look)*

- A device by the help of which we can see those objects that are too small to nacked eyes. (OR)
- A device which are used to see small objects.

Properties of Microscope:

Resolution:

- The ability of microscope to distinguished between

the two close points or objects to observed them separately is called resolution.

- Different microscopes have different resolution power.
- Resolution power of human eye = 1.0mm
- Resolution power of light microscope = 250nm
- Resolution power of electron microscope = 2 – 4A°

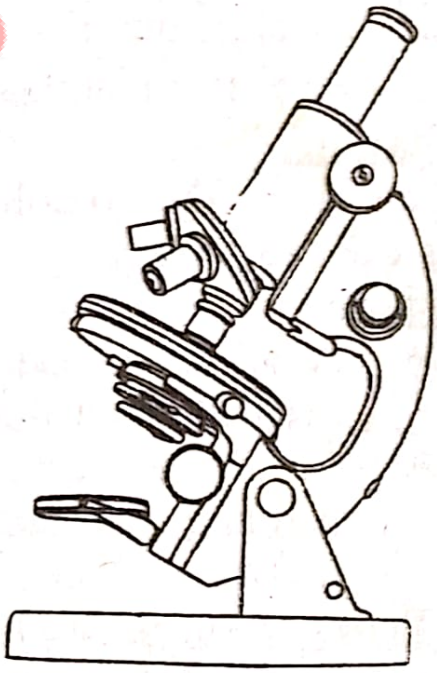
Magnification: ***(Magnification means increase in size)***

- The ability of microscope to increase the actual size of an object.
- Different microscopes have different magnification power.
- Magnification power of light microscope: 10,000x
- Magnification power of transmission electron microscope: 1000,000x.

Types of Microscope:

a. Simple Microscope:

- It do not need electricity to illuminate object.
- It contains one lens.
- It is just like magnifying glass.



b. Compound Microscope:

- The microscope which uses electricity to illuminate object is called compound microscope.
- It contains two lenses.
- One eye piece lens, on objective lens.

Electron Microscope:

- A microscope which used a beam of electron instead of electricity to illuminate object is called

electron microscope.

- This microscope is used to study those objects that are not seen by compound light microscope.
- This microscope has much larger resolution and magnification power.

Type of Electron Microscope:

Transmission Electron Microscope:

- It is used to observe the feature of very small specimen.
- It is used to observe small particles like virus.

Scanning Electron Microscope:

- It is used to see the surface of whole object.
- In this the surface of a specimen is scanned by a beam of electrons that are reflected to form an image.

1st electron microscope protype was built in 1931 by German engineer Ernst Ruska and Max Knoll.

Staining:

The use of dye to color specimen for microscopic study is called staining.

Stain:

- A substance use to import color to cell or tissue to facilitate microscopic study and examination.
- Mostly biological structures are transparent so staining provides an easy way for examination of an object.

Types of Stain:

1. Non-Vital Stain:

- Those stain which are applied to dead cells or tissue is called non-vital stain.
- This type of stain is do not applied to living cell because it causes alteration in living cells.

Types of Non-Vital Stain:

a. Acidic Stain:

It is a dye which has negative charge, hence they bind to positively charged cell structure like some protons e.g. eosine, analine blue etc.

b. Basic Stain:

The stain which is combined with acidic molecules i.e., nucleic acid, e.g, crystal violet or hematoxilin.

2. Vital Stain:

- A harmless dye which is used to stain living tissue for microscopic study is called vital stain.
- This dye cannot kills or destroy the living cells or tissues.
- This stain may be injected into a living animals and the stained tissue is removed for examination or the living tissue may be removed directly and subsequently stained. e.g., propidium iodide → DNA stain, tryphan blue, eosin etc.

Permanent Stain:

Those stains which cannot be removed from cells or tissue are called permanent stain.

Stain	Color	Used for
Aniline blue	Blue	Fungal hypae / spores
Borax carmine	Pink	Nuclei
Eosin	Pink/Red	Cytoplasm/Cellulose
Feulgen's stain	Red/Pink	DNA/Chromosome
Leishman's stain	Red/Pink/Blue	Blood cells

Temporary Stain:

Those stains which can be removed easily are called temporary stain.

Stain	Find color	Suitable for
Aniline sulphate	Yellow	Lignin
Codin solution	Blue/Black	Starch
Schullt's solution	Yellow, Blue	Lignin, protein

Centrifugation: *(Cell fractionation)*

The process of separating substances of different densities by the use of centrifuge.

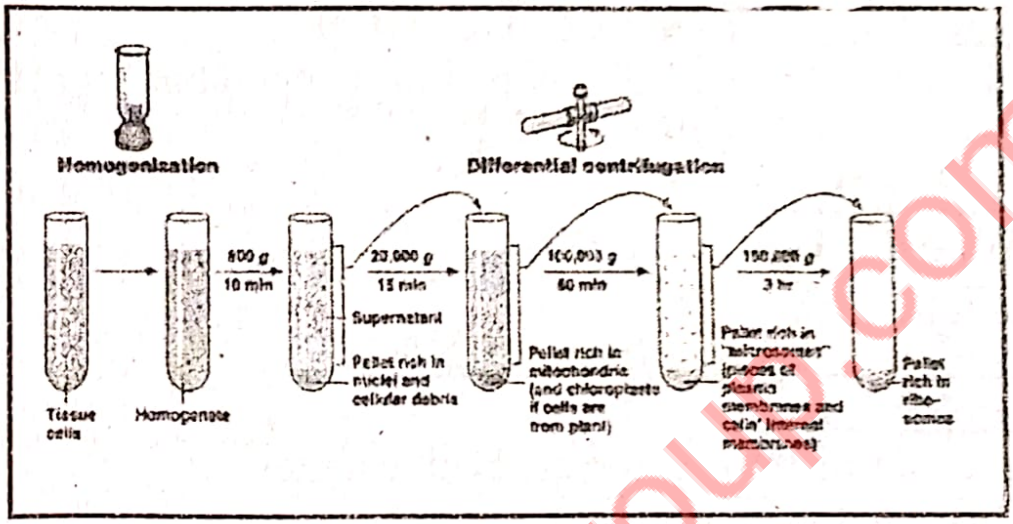
Centrifuge:

- An apparatus that rotates at high speed and by centrifugal force separates substances of different densities.
- Centrifugation is also called cell fractionation because in this technique various components of the cell is isolated in fractions or parts one by one.
- Cell contains various organelles like mitochondria, endoplasmic reticulum, golgi bodies and non-living substances. These organelles and substances are separated by and isolated by cell fractionation.

Steps:

- Grind up the tissue in a liquid medium of proper osmotic concentration to form homogenate for this purpose grinder is used.
- Pour the homogenate in a test tube and then put this test tube in a centrifuge. Now spun the centrifuge but at low speed – this will separate the larger and heavier parts of homogenate. Now separate the larger molecule from homogenate.
- After separating the heavier particle again spun the centrifuge at relative high speed. This will separate the molecules of intermediate size like mitochondria, plastids etc.

- Spun the machine again but this time the machine is spun with a higher speed. By doing this smaller and lighter cellular particles or friction precipitated or isolated.



Tissue Culture:

- The growth of a cell or tissue of living organism in a culture medium separates from living body is called tissue culture.
- It is done to produce organism of valuable character. Such organisms are cannot attacked by microbes.
- It is facilitated by the use of liquid semi-solid medium such as Broth and Agar.
- By tissue culture we produced clones in which the product cell have same genotype unless effected by mutation.

The term tissue culture was coined by American pathologist Montros Thomas Barrows.

***Broth:** A liquid medium containing proteins and other nutrients for culture.*
***Agar:** A jelly like substance obtain from red algae.*

Tissue Culture Apparatus:

1. Cell Culture hood:

- It is a cabinet that carefully encloses a bench design to prevent contamination.

2. Incubator: ***(Humid CO_2 incubator)***

It is used to maintain optimum temperature for the growth of tissue culture.

3. Water Bath:

It is used to control temperature of a sample.

4. Centrifuge

5. Refrigerator and freezer (-20°C):

6. Cell counter :

e.g. countess (OR) automated cell counter

7. Inverted microscope:

8. Liquid nitrogen (N_2) freezer or cryostorage container:

- It is used for preservation.
- It contains cryogen.

Cryogen: *The substances used to produce low temperature.*

9. Sterilizer:

Main Steps in Tissue Culture:

- Selection of plant tissue called explants from a healthy plant. It is usually taken from apical bud but other tissue can also be used such as leaves, stem and root tips etc.

Explants: *Sample obtained from any part of organism.*

- Sterilization of explants to remove microbial contaminants.
- Establish the explants in a culture medium – the medium can be solid or liquid – for each and every plant a medium should be prepared according to

their specific requirement. The medium sustain plant cell and encourage cell division.

- A callus is formed by the multiplication of explants which is manipulated by varying sugar concentration.
- Add low concentration of auxin and high concentration of cytokinin to the medium for rapid growth.
- The callus may be sub divided a number of time.
- For the formation of roots the callus is transferred to another medium with relatively higher auxin and ctyokinin ratio.
- Higher auxin ratio are required for root formation.
- Deflask the plantlet i.e. removed the plantlet from the flask and planted it again in a pot.
- The plantlet is harden off by gradual decrease in humidity.
- This is necessary to control loss of water because young plant do not have a waxy cuticle.
- At last transfer the plant to sterilize soil.

Callus: *A soft tissue that forms over a cut plant surface, it arises from the cell of cambium.*

Chromatography: ***(Chroma-Color, Graphy-to write)***

- The process of separating of one type of molecule from other in a mixture.
- The mixture in dissolved in a fluid called mobile phase which comes it through a structure holding another molecule called stationary phase.

Chromatography was employed in Russia by Italian born scientist Mikhail Tsvet in 1900.

- In chromatography the various constituent travels at different speed caused them to separate.
- The separation may also depends on a rang of chemical or physical properties such as solubility and molecular mass.

Types of Chromatography:

1. Paper Chromatography:

- The process in which a mixture is spotted near one end of the paper strip and then dipped into a specific solvent which moves through the paper by capillary action carrying the molecules with it.
- It is used for the separation of photosynthesis pigment sugar or amino acid.

2. Column Chromatography:

- It is more commonly used method which involves mobile phase flowing over a supporting matrix held in a glass tube.
- It is used to separate mixture of chemical substances into its individual compounds.

Electrophoresis:

- A method used to separate charged particles from one another on the basis of their charge and size.
- Under the influence of different electric field negatively and positively charged molecule will move towards anode and cathode respectively.

Factors effecting speed of charge molecule towards electrodes:

1. Amount of Charge:

Greater the charge faster will be the movement and vice versa.

2. Size of Molecule:

Smaller molecules will move faster and longer molecules will move slowly.

Spectrophotometry:

- A method used to measure how much a chemical substance absorbs light by measuring the intensity of light passes through the solution.
- It uses photometer called spectrophotometer.
- Every chemical compound absorbs, transmit or reflect light over a certain range of wavelength.
- The determination of amino acid by spectrophotometer analysis is based on specific light absorption.
- The analysis of amino acids generally depends upon absorption exhibited by their color derivatives.

Spectrophotometer: A device which measure the amount of ultraviolet light absorb by a substance.

MICRO-DISSECTION:

The technique in which a microscope is used to assit dissection of cells or its organelles.

Techniques involved in micro-dissection:

a. Chromosome micro-dissection:

- In this technique we remove a large section of DNA from a complete chromosome physically.
- In this we use fine glass needles under microscope to remove a portion from a complete chromosome.

b. Laser micro-dissection:

- It is a technique in which microscope is used to dissect specific cells.

c. Laser capture micro-dissection:

- The use of laser through a microscope to cause selected cells to adhere to a film.

MICROMETERY

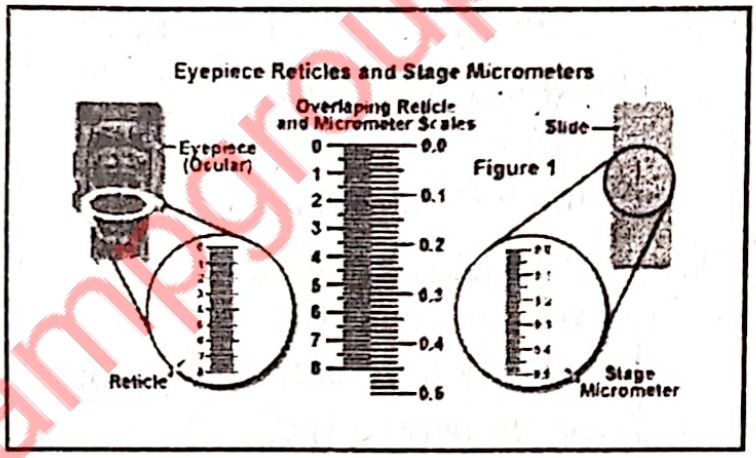
- The measurement of dimension of desired micro organism under microscope.
- It uses two micro scales called micro meter.

a. Ocular micrometer:

- It is a graduated scales that is kept on eye piece.

b. Stage micrometer:

- This scale is kept on the stage of microscope.
- These two micrometers have equally spaced division.
- For the measurement of a particular structure first you have to find out the real width of each unit scale at each magnification of eye piece micrometer.



- It can be done by replacing the specimen with the stage micrometer, the eye piece unit at each magnification.

CELL WALL:

- It is the outermost boundary of plant cell. It is absent in animals cell.
- It is non-living.
- It is secreted by protoplasm for its protection.
- It forms during telophase stage of cell division.

History of Cell Wall:

- It was 1st observed by Robert Hook in 1665 and named only is a wall.

- In 1804 Karl Rudolphi and J.H.F link proved that cells have independent cell wall.

Chemical nature of Cell Wall:

- Cellulose
- Hemi cellulose
- Lignin
- Cutin
- Subrin
- Pectin
- Mucilage
- Minerals

a. Cellulose:

- It is polysaccharide containing thousands of glucose units.
- It is insoluble carbohydrate.
- Due to this cell wall become soft and elastic.
- It is permeable to water.

b. Hemi Cellulose:

- It is a mixture of many organic compounds.
- It is found in heavily thickened walls e.g. cell wall of endosperm of date palm, strong seeds and fruits of plants.

Lignifications: *The process of lignin deposition in cell wall is called lignifications.*

c. Lignin:

- It is a hard, tough and complex polymer.
- It is found in woody tissue of the plant.
- Its deposition makes the cell wall thick.

d. Cutin:

- It is a chemical substance made of fatty acid and

wax.

- It is present in cuticles of young stem, leaf, flower an fruits.
- It is impermeable to water hence prevent water loss by evaporation.

e. Subrin:

- It is a fatty substance founds on the walls of cork cells due to this it become impermeable and dead.

f. Pectin: (A biological plastic)

- It is a sticky and gel like substance found in middle lamella.

Layer of Cell Wall:

It is composed of 3 layers:

PRIMARY WALL:

- It is the outermost wall of cell.
- It is found around a young plant cell.
- It is elastic, thin and capable of extension.
- It is crystalline and optically active.
- *Size:* Usually 1 – 3 micrometer.

Chemical Composition:

It is composed of cellulose, hemi cellulose, pectin and sugar compound.

SECONDARY WALL:

- It is formed on the inner side of primary wall in an old and large cell.
- It is tough and strong.
- It is thick and less rigid.
- It is permeable.
- It is crystalline and optically active.
- *Size:* 5 – 10 micrometer in thickness.

Chemical Composition:

It is chemically composed of cellulose, hemi cellulose,

lignin and silica etc.

MIDDLE LAMELLA:

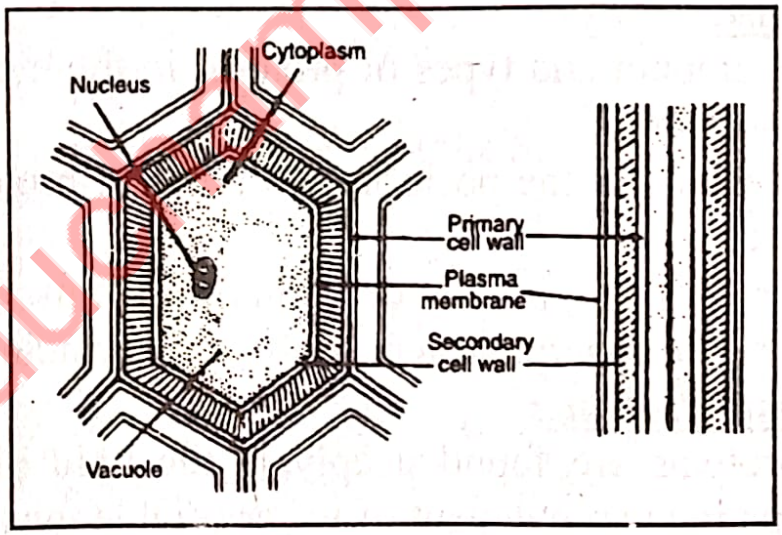
- It is a layer which is found between two cells.
- It helps in the attachment of two cells.
- Size Micrometer in thickness

Chemical Composition:

- It is composed of calcium and pectin.
- It occurs in the form of calcium pectate.
- It is lignified in woody tissues.

Functions of Cell Wall:

- It gives a definite shape and structural frame work to the cell.
- It protects the inner content of cell.
- It provides mechanical support to the cell.
- It is a permeable membrane for diffusion and helps in the absorption of minerals and solutes along with water.



Q1: Write a detailed note on structure and function of plasma membrane.

Ans. Plasma Membrane / Cell Membrane:

- It is the outermost boundary of animal cell while in

plant cell it lies next to cell wall.

Plasma membrane is also called plasmallema cytoplasmic membrane and cell membrane.

History:

- The term cell membrane was coined by C. Nageli and C. Cramer in 1855 and the term plasmallema has been given by J.Q Plowe in 1931.

Physical Properties of Cell Membrane:

- It is thin.
- It is 7nm wide
- It is elastic.
- Cell membrane is semi permeable.

Chemical Composition:

It is chemically composed of:

- Proteins (60 – 80%)
- Lipids (20 – 40%)
- Carbohydrates (2 – 10%)

1. Proteins:

- The amount and types of proteins in the membrane are variable.
- According to the position two types of proteins are present.
  - Integral protein or intrinsic proteins
  - Peripheral protein or extrinsic proteins

a. Intrinsic Proteins:

These proteins are found deeply in the lipid bilayer – they helps in the movement of water soluble ions outside or inside the cell. Hence these proteins are also called permeases.

b. Extrinsic Protiens:

These proteins are present along the surface of lipids.

They have loose attachment with membrane surface.

2. Lipids:

Four types of lipids are found in plasma membrane:

- Phospholipids
- Sphingo lipids
- Glycol lipids
- Sterol (Cholesterol)

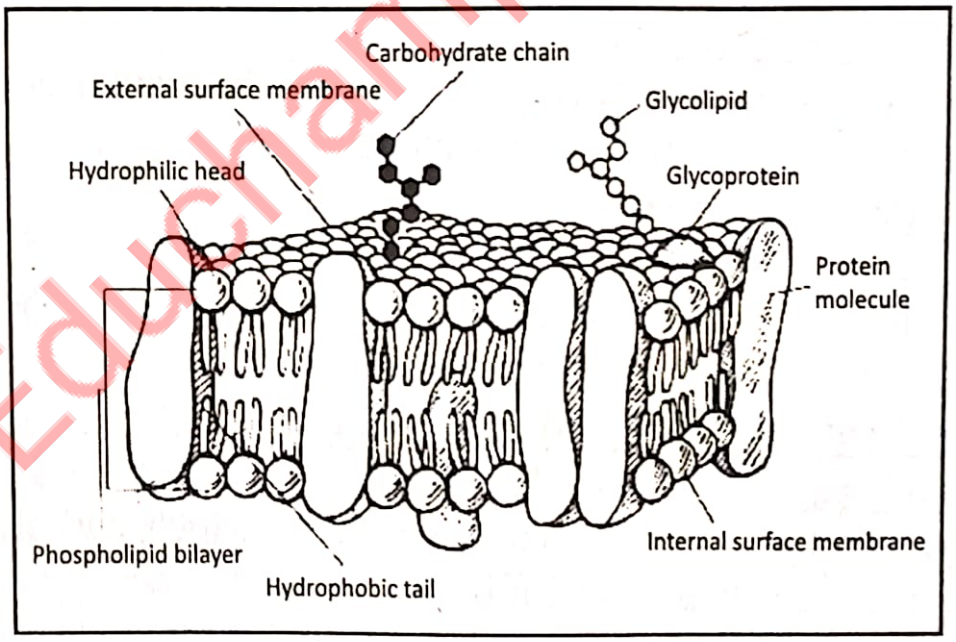
Phospholipids are amphipathic molecules i.e. it posses both hydrophilic (head) which is formed by phosphate and hydrophobic tails which is formed by fatty acids.

Structure of Plasma Membrane:

There are various models about the structure of plasma membrane but the most accepted model is fluid mosaic model.

Fluid Mosaic Model:

This model was presented by S.J Sanger and G.L Nicolson in 1972.



Statement:

According to this model the lipid molecules forms two

layers called lipid bilayer which is a fluid structure. The protein molecules do not form a continuous layer rather they floats about in the fluid lipid bilayer. Since the protein molecules are scattered in the fluid lipid bilayer in a mosaic pattern so the structure is called fluid mosaic model. As regarded the position of protein molecul they are of two types i.e. intrinsic proteins and extrinsic proteins.

> ***Various models about plasma membrane:*** *Gorter and Grinder proposed two layer of lipid molecule only in 1925.*
> ***Daniel and Davon (1935):*** *Lipid bilayer is covered with proteins and protein pores.*
> ***Robertson (1959):*** *Unit membrane model.*
> ***Singer and Nicolson (1972):*** *Fluid mosaic model*

a. Protein and their role:

Proteins are floats in the sea of lipid molecules. As we know that two types of proteins are present.

(i) Extrinsic Proteins:

It acts as receptors that receive stimulus from outer environment and inform cell for respond.

(ii) Intrinsic Proteins:

- These are also called permeases.
- It transports those substance to the cell for which the membrane is impermeable.

b. Role of glycolipid and glycoproteins:

(i) Glycolipids: (Glyco-Glucose)

Glycolipid is a conjugated molecule in which carbohydrates are get attached with lipids.

(ii) Glycoproteins:

Glycoprotein is also a conjugated molecules in which carbohydrates is attached with proteins.

Functions:

- It provides a receptor site that receive different types of stamulis like nerve impulse, hormone receptor site, recognition of antigen and food material etc.
- It is involved in endocytosis i.e. phagocytosis and pinocytosis.
- It acts a cell surface marker.
- Lipid bilayer makes the membrane differentially permeable barrier that allows the transport of non-polar materials across it and prevent ionic materials.
- Membrane proteins acts as selective permeable membrane.
- Integral proteins regulate diffusion, osmosis and active transport of ionic materials.

Function of Plasma Membrane:

- It protects the cytoplasm of a cell.
- It gives mechanical strength and support to the cell.
- It is being semi permeable so it allows and prevent selective materials to pass through it.
- It restricts the inner contents to escape from the cell.
- It excretes waste substances from cell.
- It also secretes useful substance such as enzymes and hormones etc.

Q2: What is cytoplasm? Write the function and structure of its organelles.

Ans. Cytoplasm:

The space or region between plasma membrane and nucleus is called cytoplasm.

Physical Properties:

- It is colorless and concentrated liquid.

- It is elastic.
- It is insoluble in water but can absorb a large amount of water in it.
- It is semi – transparent.

Parts or division of Cytoplasm:

- Cytosol
- Cytoplasmic structure

1. Cytosol:

- It is the soluble part of cytoplasm.
- It is aqueous and dissolve great variety small molecules i.e. glucose, amino acid, vitamins and minerals etc.
- It contains soluble proteins and vitamins.
- Cytosol is composed of true solution and colloidal solution.

a. True solution:

It contains small size molecules of life such as salt, sugar, amino acids and vitamins which is dissolved in water forming homogenous system (water + salt + sugar + amino acid + vitamin etc).

b. Colloidal solution:

- It contains large size molecules such as proteins, fatty acid and RNA molecule etc. forming heterogeneous system. (Water + protein + fatty acid + RNA etc).
- The colloidal solution may be of sol state (solution or runny) or may be of gel state (jelly like).
- Usually the outer region of cytoplasm is more gel like.

2. Cytoplasmic structures:

Cytoplasmic structures are of two types:

- Inclusion

- Cell organelles

RBC, egg and embryonic cell lack in endoplasmic reticulum.

a. Inclusions:

- It is non-living structures known as paraplasm.
- It includes stored food, secretary substances, oil drops etc.

b. Cell organelles:

It is living structures. These are the sub cellular particles.

Functions of Cytoplasm:

- It is a store house for various organelles.
- It stores biochemical molecules such as amino acids, sugar, nucleotides etc.
- It acts a site of various metabolic pathways such as glycolysis.
- It contains cytoskeleton which maintain the shape of cell and also helps in movement.

CYTOPLASM ORGANELLES:

1. Endoplasmic Reticulum:

Endo – inside, plasmic – cytoplasm, reticulum-network

- It is a system of flattened membranes bound sacs forming a network throughout the cytoplasm.
- It forms a connection between cytoplasm and nucleus – these are inter connected channels.

Discovery:

Endoplasmic reticulum was first reported by Porter in 1953, who is 1945 had observed it in electron micrographs of liver cells.

Occurrence:

- E.R occurs in all eukaryotic cell but their occurrence varies from cell to cell.
- The cells of those organ which are actively engaged in protein synthesis contain rough endoplasmic reti-

culum e.g. pancreas, goblet cells and cells of endocrine glands.

- Liver cells contain both smooth endoplasmic reticulum and rough endoplasmic reticulum.

Membrane of Endoplasmic Reticulum:

Endoplasmic reticulum is composed of lipo - proteins means that it is made of lipids and proteins.

Morphology of Endoplasmic Reticulum:

Morphology endoplasmic reticulum occur in three forms:

a. Cisternae:

- The cisternae is long, flattened sac like unbranched tubules having the diameter of 40-50 μm.
- They remain arranged parallely in bundles.

b. Vesicles:

- Vesicles are oval membrane bound vacuolar structure having the diameter of 25 - 500 μm.
- They often remain isolated in cytoplasm.

c. Tubules:

These are branched structures forming the reticular system along with cisternae and vesicles.

Types of Endoplasmic Reticulum:

There are two types of endoplasmic reticulum:

- Rough endoplasmic reticulum
- Smooth endoplasmic reticulum

a. Rough Endoplasmic Reticulum:

- It is granular hence also called granulated endoplasmic reticulum.
- On the surface of this endoplasmic reticulum ribosomes are present.
- Rough endoplasmic reticulum is found abundantly in those cells which are active in protein synthesis

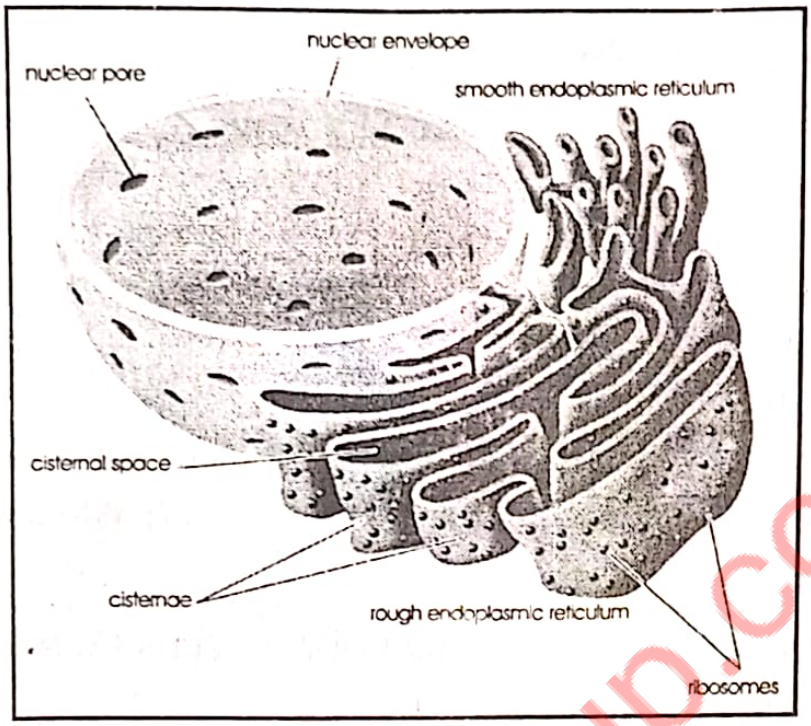
such as pancreas cells.

b. Smooth Endoplasmic Reticulum:

- It is a granular because this type of endoplasmic reticulum does not contain ribosome.
- This type of endoplasmic reticulum contains smooth walls so called smooth endoplasmic reticulum.
- They are mostly present in steroid producing cells such as interstitial cells and muscles cell etc.

Functions:

- It helps in the exchange of materials between cytoplasm and nucleus.
- It provides mechanical support to the cytoplasm.
- It provides a plate form for the attachment of ribosome.
- Rough endoplasmic reticulum involved in protein synthesis.
- Rough endoplasmic reticulum is also involved in the production of new membranes.
- It is involved in lipid synthesis.
- Smooth endoplasmic reticulum converts cholesterol of skin into vitamin-D.
- Smooth endoplasmic reticulum plays a role in muscle contraction.
- Smooth endoplasmic reticulum in liver helps in detoxification of drugs.
- Smooth endoplasmic reticulum produces steroid hormones.



RIBOSOME:

Discovery:

- Ribosomes were discovered by Palade in 1955.
- Ribosomes are small dense, rounded and granular particles.

Occurrence:

- Ribosomes are occurs in both prokaryotic and eukaryotic cells.
- They occur freely in cytoplasm or may attached with endoplasmic reticulum.

Size: Its size is ranging from 150 - 250 A° (in diameter)

Number of ribosomes in a cell: E-coli (prokaryotic cell) contain 10,000 ribosomes. Mammalian cultural cell contain 10 million ribosomes.

Shape: They are oblate spheroid structure.

Chemical Composition:

- It is composed of proteins and ribosomal RNA.

Structure of Ribosome:

Each ribosome is composed of two sub-units:

- Small sub-unit
- Large sub-unit

Small sub-unit have smaller size and occurs above the large sub-unit which forms a cap like structure. The two sub-units are joined together by high concentration of magnesium ion. When the concentration of Mg^{2+} is reduced both the unit will be get separated.

Types of Ribosome:

Ribosomes are classified into two types on the basis of size and sedimentation coefficient(s).

70s Ribosome:

It is small in size. Its small sub-unit is 30s and large sub-unit is 50s. They combine to form 70s (this is formed because some part of both overlap like the cover and body of writing pen). It occurs in prokaryotic cell. (30s + 50s = 70s).

80s Ribosome:

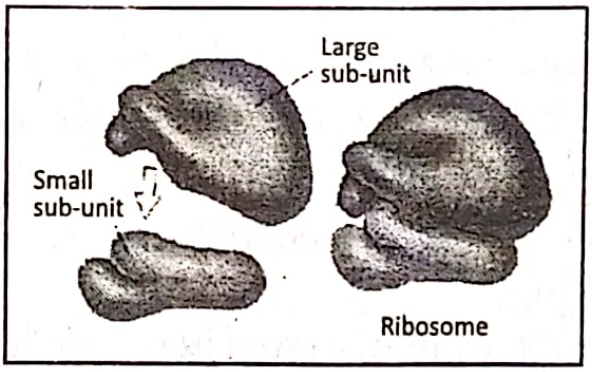
This type of ribosome is large in size and it is found in eukaryotic cells. Its small sub-unit is 40s and large sub-unit is 60s forming 80s. 40s + 60s = 80s.

Site of Synthesis:

Ribosomes are synthesized in nucleolus of a nucleus and then transferred to cytoplasm through nuclear pores.

Function:

Its function is the synthesis of proteins.



GOLGI APPARATUS (DICTYSOMES):

Discovery information:

- It was discovered by an Italian neurologist (i.e. physician) Camillo Golgi in nerve cell in 1898.
- It is a double membrane bounded structure which contains stacks of flattened sacs present in the cytoplasm.

Chemical Composition:

Proteins, lipids and enzymes

Occurrence:

It occurs in all cells except prokaryotic cells. It occurs abundantly in secretary and nerve cells.

Distribution:

- It is localize in animals cells i.e. it is found near the nucleus forming a complex structure called golgi complex.
- In plant cell, it is not localized i.e. it is scattered in cytoplasm.

Morphology:

Golgi bodies are consists of three parts:

a. Cisternae:

- These are flattened sac like structures found very close to each other. It is about 1μm in diameter.
- They may be flate or curved.
- They are dilated at their margins.

b. Golgi Vesicles:

- These are small rounded structures which are attached to tubules at the outer surface of cisternae.
- These vesicles contain secretary materials.
- They are 60nm in diameter.

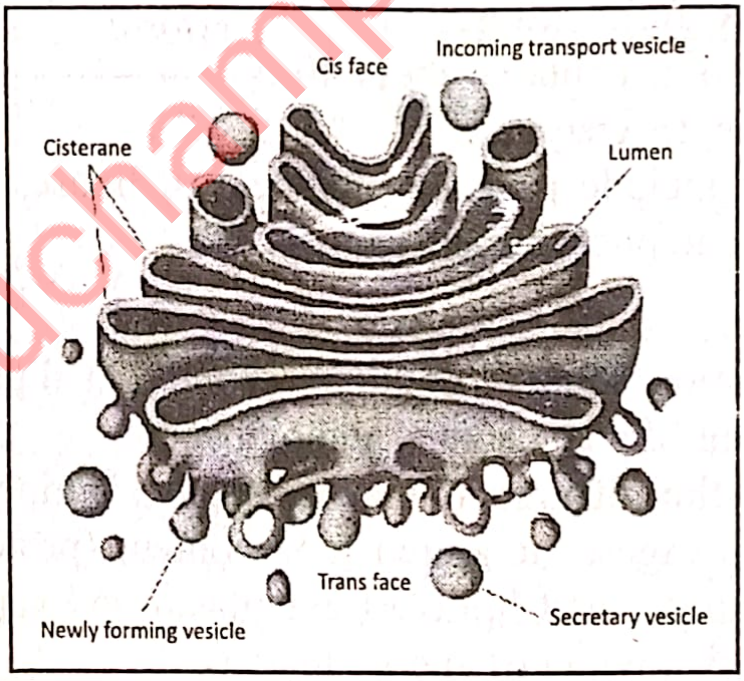
c. Tubules:

It is a complex array of associated vesicles which is 30 –

50nm in diameter.

Functions:

- It is often refer as the traffic police of the cell, because it plays a key role in sorting many of cell protein and membrane constituents, and in directing them to their proper destination.
- It modifies materials chemically and then transports it.
- It is involved in packaging of materials.
- It helps in the formation of new plasma membrane.
- In animals cells it is involved in the secretion of many enzymes, hormones and other substances.
- Primary lysosome is also formed by Golgi bodies.
- It is involved in the assembling of large molecules such as glycoprotein and glycolipids.
- It is involved in the secretion of waxes, gums and mucilage from many plant cells.



LYSOSOME: ***(Gr: Lyso, Digestive + Soma – body)***

- These are tiny membrane bounded vesicles in-

volved in intra cellular digestion.

- They contain a variety of hydrolytic enzymes that remain active under acidic condition (5pH).

Discovery information:

It was discovered by C. de Duve in 1955.

Occurrences:

- It occurs in most animal cells and in few plant cells.
- They are absent in prokaryotic cells.

Size: Its size is about 0.2 – 0.5 μm but may vary from cell to cell.

Structure:

- These are rounded vacuolar structure which remains filled with dense material.
- It is bounded by a single membrane.
- Their shape and density vary greatly.

The membrane of lysosome normally keep the enzyme latent and out of cytosol.

Chemical Composition:

- Lysosome contains about 40 hydrolytic enzymes.
- They include proteases, nucleases, lipase, glycosidase and phospholipase etc.

Functions:

- Digestion of extra cellular particles; it digest food content of phagosomes and pinosomes.
- Digestion of intracellular substance; during starvation it digest the stored food content (protein, carbohydrates and lipids of cytoplasm and supply necessary amount of energy to cell).
- Autolysis (auto-self, lysis-digestion): In certain pathological condition it digest its own cell (cellular

autophagy)

- They play role in development process.
- It also eat microorganism that enters the cells.
- Lysosome of certain cells such as sperm discharge their enzyme outside which digest the membrane of ovum.

Malfunction of Lysosome:

- Malfunction means failure (fail) to function.
- Malfunction of lysosome results in various pathological disorders.
- Some are congenital (in born) caused by gene mutation.
- Examples: Glycogenosis type II, Tay, Sach's disease.

Glycogenosis Type II (GSD):

- Also called pomp's disease.
- It is caused by the accumulation of glycogen in lysosome due to the deficiency of lysosomal acid alpha glycosidase enzyme.
- It damage muscle and nerve cells throughout the body.

Symptoms:

- Muscle pain
- Frequent falls
- Jaw muscle fatigue
- Difficulty in climbing stairs

Tay Sach's Disease (TSD):

It is a fetal genetic disease commonly occurs in childrens which destroy nerve cells of the brain.

Causes:

It is caused due to the accumulation of fatty substances (lipids) called Gm2 ganglioside in the cells due to the

absence of an enzyme hexosaminidase.

Symptoms:

- Loss of motor skills
- Sezures
- Vision and hearing loss
- Muscle weakness
- Movement problems

Perxisomes: ***(Peroxi-peroxide, soma-body)***

Also called micro bodies.

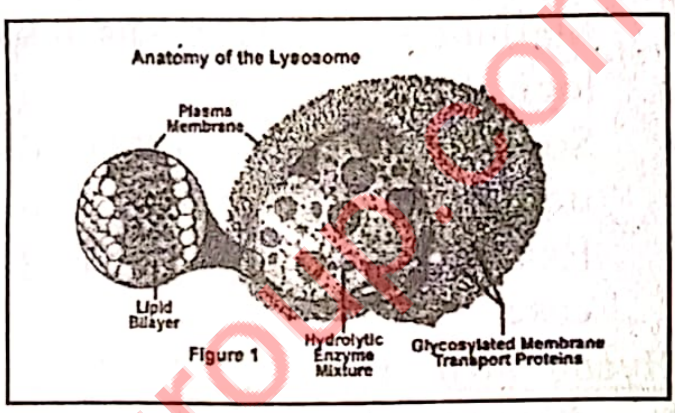


Figure 1

Discovery:

- C.De Duve and co-workers in 1996 in liver cells.
- It is a small organelle present in the cytoplasm of many cells.
- It is membrane bounded organelle.
- It contains enzymes that oxidize certain molecules normally found in the cell notability fatty acids and amino acids.
- Those oxidation reactions produces peroxides (H_2O_2) which is the basis of the name peroxysome.
- It contains catalyzes enzymes.

Size: It is about 0.5 μm in diameter.

Structure: It is rounded in structure.

Occurrence:

- It occurs in plants and animals cell.
- In plant cell it remains associated with endoplasmic reticulum. Chloroplast and mitochondria and are involved in photorespiration.
- In animal cells it is mostly occurs in liver and kidney.

Functions:

- In plants it is involved in photorespiration.
- They breakdown hydrogen peroxide (H_2O_2) into water and oxygen.
- They protect the cell from the corrosive effect of H_2O_2.
- Destroy the toxic effect of alcohol.

GLYOXYSOMES:

Discovery:

- Discover by Beevers in 1969.
- It is a tiny organelle found only in plant cell.
- It is mostly occurs in oil rich seeds.

Size: It is about 6.0 μm in diameter.

Structure: It is circular in shape surrounded by a single membrane.

Chemical Compositions:

Glycolic acid, oxidase, catalase, they also contain enzymes for fatty acid metabolism.

Functions:

- Conversion of fatty acids into carbohydrates during germination of seed e.g. (sunflower, castor oil etc.)
- This process is achieved by a glyoxylate cycle.

CYTOSKELETON:

Discovery:

- Discover by Koltzoff in 1928.
- It is a complex network of proteins filaments extended throughout the cytoplasm.
- The shape of the cell depends upon the cytoskeleton.
- It is spongy in nature and found in eukaryotic cells.

Chemical Compositions:

- Actin
- Tubulin

- Myosin
- Tropomyosin

Cytoskeleton consists of three types of protein filaments:

a. Microfilaments:

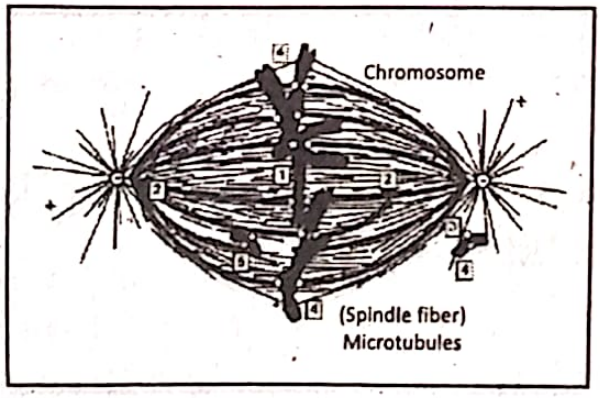
- It is a small rod like structure extended in the cytoplasm of a cell.
- It is 4-7nm in diameter.
- It occurs in the form of bundles.
- It is made of contractile proteins called actin and myosin.

Functions:

- They have a role in muscle contraction.
- They help in movement in almost all eukaryotic cells.
- They give support and strength to the cell.
- In plants cell it is involved in streaming movement of cytoplasm.
- They may be involved in the formation of endocytotic vesicles.

b. Microtubules:

- It is a microscopic tubular structure present in the cytoplasm of a cell.
- These are long, unbranched and cylindrical structure.
- It is the longest cytoskeletal filament.
- They are made of globular protein called tubulin.



Functions:

- It is involved in the formation of centriol, basal bodies, cilia and flagella.
- They form spindle fibers of the dividing cells.
- They are responsible for the movement of chromosome in a cell.
- It provides support and strength of the cell.
- It maintains the structure of a cell.

c. Intermediate Filaments:

- These are intermediate between microtubules and microfilaments.
- They are 8-11nm in diameter.
- They are made of fibrous proteins.

Functions:

- It provides mechanical support to the cell.
- In eukaryotic cells it supports the nuclear membrane.
- It maintains the shape of the cell.

CENTRIOLS:

Discovery:

It was discovered by Edouard Van Benedun in 1883 and the named was given by Theoder Boveri in 1888.

- It is a cylindrical cellular organelle present near the nucleus.
- It is a small hollow cylindrical organelle which occurs in pair form.
- It is placed at right angle to each other and just before cell division it duplicates and moves to opposite pole.

Size: It is about 0.2 μm in diameter and 0.3 – 0.5 μm in length.

Occurrence:

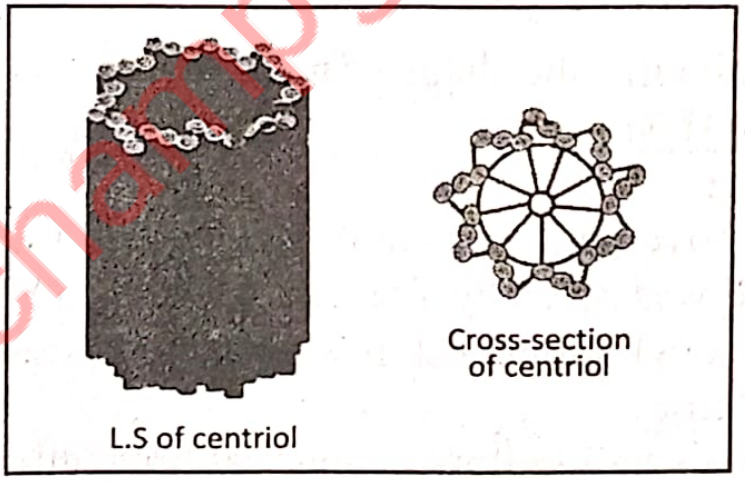
- It occurs in animals, microorganisms and lower plants.
- It is absent in higher plants.

Structure:

- Under electron microscope the cross section of centriol is.
- It is made of nine sets of microtubules.
- These microtubules arranged in a circular manner forming a hollow cylinder.
- Each set of microtubule is composed of three microtubul
- Total number of microtubules in one centriol is 27.

Functions:

- It is involved in cell division.
- They are helps in the formation of cilia and flagella.



CILIA AND FLAGELLA:

Cilia:

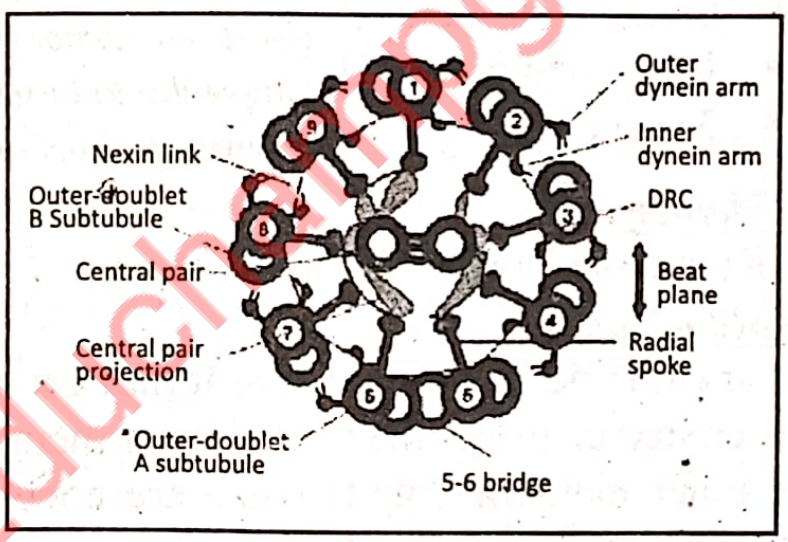
L.cili, eye lash and flagella is derived from L. little whipe. Both the cilia and flagella are microscopic contractile and filamentous processes of the cytoplasm. Morphology and physiologically cilia and flagella are

identical structure but even then it can be distinguished from each other by size and function.

Cilia	Flagella
1. It is small in size = 5–10μm	1. It is long in size upto 150 μm.
2. It is more in number (3000-14000)	2. It is less in number (1-2)
3. It occurs throughout the surface of a cell.	3. It occurs at one end of the cell.
4. It beats in coordinate rhythm.	4. It beats independently.

Internal Structure of Cilia and Flagella:

- It consists of 9+2 structure called axoneme.
- The axoneme consists of a outer pair of microtubules and 2 single central microtubule.



MITOCHONDRIA: ***(Mito-thread, condrion, small grain)***

Discovery:

By Kooliker in 1850 in skeletal muscle

- It is also called condriosome and power house of the cell.
- Mitochondria are granular bodies present in the cy-

toplasm of eukaryotic cells.

- Under light microscope it appears as vesicles, rods or filaments.

Size: It is 1.0 µm to 10.0µm in length and 0.5 µm to 1.0µm in width

Shape: It may be filamentous or granular in shape.

Numbers:

- It is more in number in animals than plant cells.
- In animal cells its number is vary from cell to cell depending upon the function of a cell.

Chemical Composition:

Proteins, lipids, DNA and small amount of RNA

Structure:

- It appears oval under electron microscope.
- It consists of mainly three parts:
  - Outer membrane
  - Inner membrane
  - Matrix

Heart cell cannot get fatigue due to large number of mitochondria.

a. Outer Membrane:

It is smooth and made of lipids and proteins.

b. Inner Membrane:

- This membrane is folded inward forming a cristae.
- This cristae increases the area of inner membrane.
- The inner membrane and cristae are covered with knob like particle called F1 particles or elementary particles.
- The function of F1 particles is synthesis and oxidation of ATP.

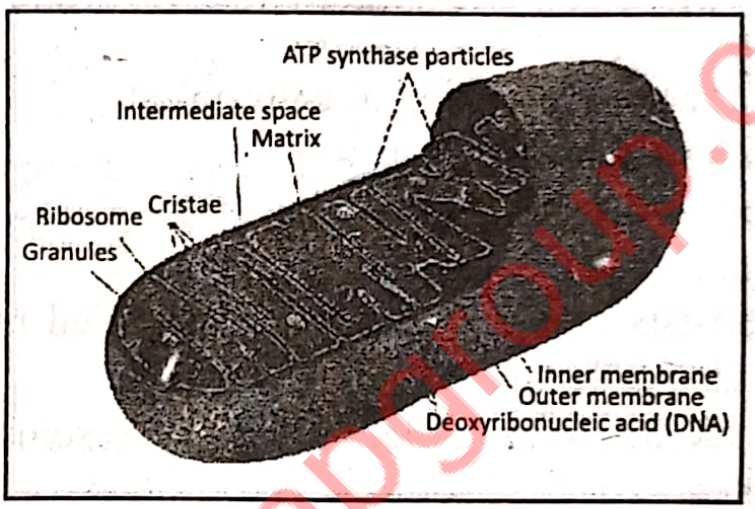
c. Matrix:

- It is the inner dense portion of mitochondria.

- It is consist of homogeneous gel like material which contains lipids, proteins, enzymes, ribosome, Na^+, K^+, NAD, FAD etc and small amount of DNA.

Functions:

- They are involved in cellular respiration during which organic food molecules are broken down into simpler substances and energy is released.
- Cells use this energy to perform various functions.



PLASTIDS: ***(Plastikos – moulded)***

Discovery:

Described by Anton Von Leeuwenhoek

The term plastid was used by Schimper in 1885.

- It is membrane bounded organelle present only in plants cell.
- Plastids contain special pigments.
- They are spherical or disc like in shape.

Types of Plastids:

On the basis of function and pigment plastids are classified into three types:

a. Chloroplast: ***(Chloro-chlorophyll, plast-plastid)***

- Chloroplasts are green plastids.
- It contains green pigment called chlorophyll.

Shape: They are usually oval or disc shaped.
Size: They are vary in size from 5μm – 10μm in diameter and 1μm – 5μm in length.

- The number of chloroplast is vary from cell to cell.
- Higher plants cell have about 20 – 40 chloroplast.
- Chloroplast is mainly present in leaves of the cells.

Structure of Chloroplast:
It consists of three main components:

(i) Envelop:
- It is the outer covering of chloroplast.
- It is double layered structure.
- It encloses the grana and stroma.

(ii) Grana:
- It consists of many flattened fluid filled membranous disc called thylakoids.
- Thylakoids forms stakes which are resemble a pile of seed.
- Thylakoids are grouped together forming a granum.
- Granum are connected to each other by intergrana.
- Intergrana do not posses chlorophyll.

A granum is made up by the combination fo 50 or more thylakoid.

(iii) Stroma:
- The central space inside the double membrane envelop in stroma.
- It contains fluid which is composed of enzymes, co-enzymes, ribosome CO_2 and small amount of DNA etc.

b. Chromoplast: ***(Chromo-color, plast-plastid)***
- These are colored pigment other than green.
- They may be red, pink, yellow, blue etc.

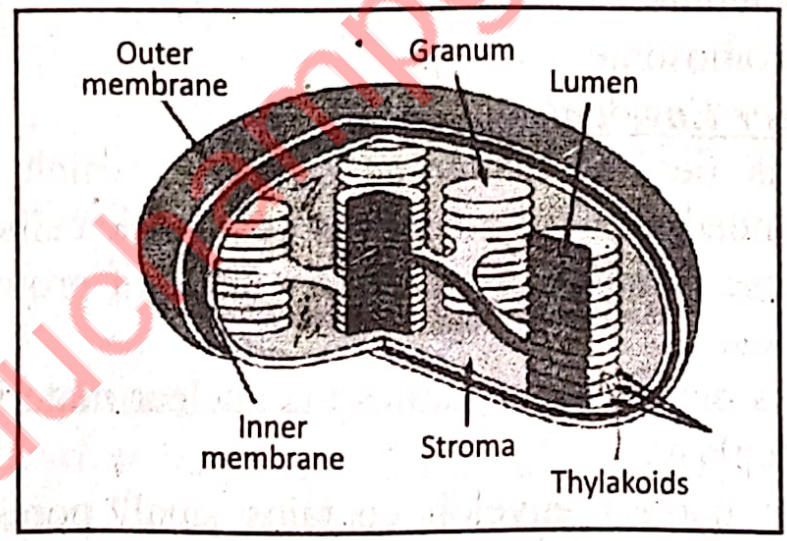
- They are mostly founds in flowers particularly in petals and fruits.

c. Leucoplast: ***(Leucos-white, plast-plastid)***

- These are colorless plastids.
- They are mostly found in food storage parts of the plants i.e. roots.

Functions of Plastids:

- They are directly involved in photosynthesis.
- The grana of chloroplast perform light reaction while stroma performs dark reaction of photosynthesis.
- Chromoplasts are brightly colored so they attract insects for pollination.
- Chromoplast also gives aesthetic beauty to various fruits.
- Leucoplasts help in the storage of food.



NUCLEUS: ***(L..nux = nut)***

Discovery:

By Robert Brown in 1838

- It is the most important and prominent body of eukaryotic cell.

- It is the largest cell organelle.
- It is absent in prokaryotic cells.

Shape of Nucleus:

- The shape of the nucleus is related with the shape of cell.
- It is usually spherical or cuboid.

Size:

- It is vary in size from about 3μm to 10μm in diameter.
- The size of the nucleus is directly proportional to the size of the cytoplasm.

Structure of Nucleus:

The nucleus is composed of the following four components:

- Nuclear envelop
- Nucleoplasm
- Nucleolus
- Chromosome

a. Nuclear Envelop:

- It is double membrane structure which is surrounded from the nucleus of eukaryotic cells.
- These membranes are mostly made of proteins and lipids.
- This membrane separates the nuclear material from cytoplasm.
- The nuclear envelop contains small pores called nuclear pores.
- These nuclear pores allow the exchange of substances between the nucleus and cytoplasm.
- The nuclear pores are associated with protein molecules which regulate the passage of material to and from the nucleus.

- The numbers of nuclear pores are variable from cell to cell.

b. Nucleoplasm:

- A semi liquid matrix inside the nucleus is called nucleoplasm.
- It contains chromosome and other substances embedded in it.
- It contains enzymes, proteins, lipids and minerals.

c. Nucleolus:

- It is a spherical structure found inside the nucleus.
- There may be one or many nucleoli in a single nucleus.
- It is composed DNA, RNA and proteins.
- Their main function is the synthesis of ribosomes.
- During cell division nucleolus disappear in prophase and reappear in telophase.

d. Chromosomes: ***(Chorma-color, soma-body)***

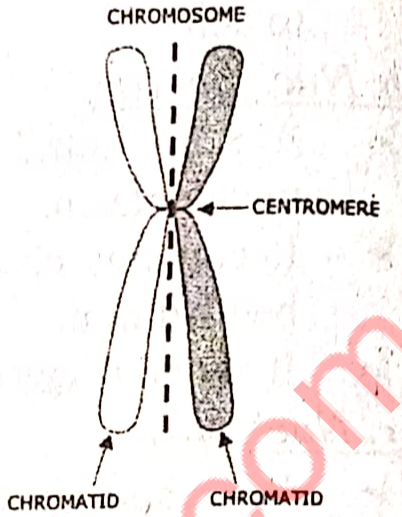
- It was discovered by Waldyer in 1876.
- Chromosomes are called colored bodies because they are deeply stained with basic dyes.
- They are the main structure inside the nucleus.
- During metaphase stage of cell division chromosome is more visible.
- Chromosome forms a network in interphase stage of cell division called chromatin material.

Chemical Composition:

It is composed of DNA and proteins.

DNA = 45%, proteins = 55%

Structure:



- It consists of centromere and chromatids.
- **Centromere:** It is a central point on which two arms of chromosomes are attached.
- **Chromatids:** During cell division chromosome forms it duplicate called chromatids.

Number of Chromosome:

The number of chromosome is different in different species. Examples:

- → Human = 46
- → Garden pea = 14
- → Chicken = 78
- → Onion = 16
- → Grass hopper = 24
- → Maize = 20
- → Rhesus monkey = 42
- → Tomato = 24
- → Pigeon = 80
- → Fruit fly = 8
- → Tobacco = 48

Functions of Nucleus:

- It is regarded as the control room of the cell because it controls and manages all the activities of the cell.
- It is the site of heredity material in the form of DNA.
- It transfers the characters from parents to offsprings.
- It helps in cell division.

Differentiate between Prokaryotic and Eukaryotic Cell:

Prokaryotic Cell	Eukaryotic Cell
Pro-before, karyom-nucleus	Eu-true, karyon-nucleus
1. Well develop nucleus is absent.	1. It contains a well develop nucleus.
2. They are small in size (1-10 μm)	2. They are large in size (10-100 μm)
3. Nuclear membrane is absent.	3. Nuclear membrane is present.
4. Plasmids are present.	4. Plasmids are absent.
5. Small size ribosome (70s)	Large size ribosome (80s)
6. Chromosomes are disperse in cytoplasm.	6. Chromosomes are present in nucleus.
7. Membrane bounded organelles are absent.	7. Membrane bounded organelles are present.
8. Cell wall is made of murin (bacteria).	8. Cell wall is made of chitin (fungi) and cellulose (plants).
9. Nucleoli is absent.	9. Nucleoli is present.
10. Cytoskeleton is absent.	10. Cytoskeleton is present.
11. Chromosome is only composed of DNA.	11. Chromosome is composed of DNA and proteins.
12. Respiration takes place in mesosome.	12. Respiration takes place in mitochondria.

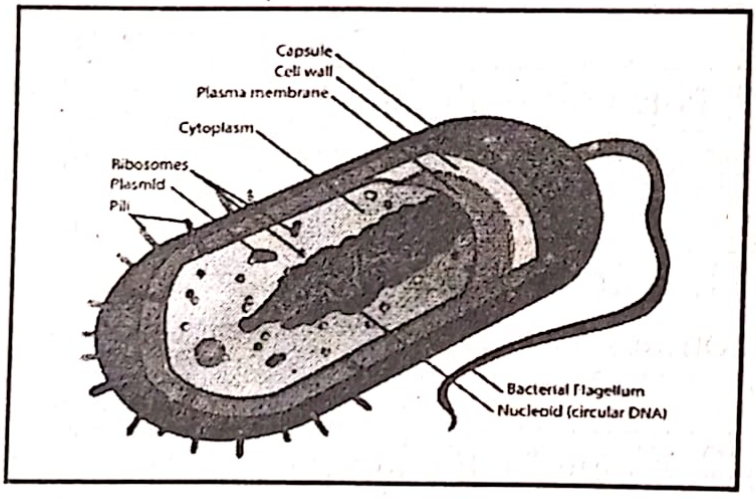
13. Meiosis and mitosis are absent.	13. Meoisis and mitosis takes place.
14. They are unicellular.	14. They are mostly multi-cellular.
15. Cytoplasm streaming movement absent.	15. Cytoplasm streaming movement occurs.
16. Chlorophyll are dis-perse in cytoplasm if oc-curs.	16. Chlorophyll occurs in chloroplast.
17. Cell is divided by bi-nary fission.	17. Binary fission normally absent.
Examples: Bacteria and cyanobacteria	Examples: Animals, plants, fungi and protests

Structure of Bacteria as a Model Prokaryote:

- Bacteria are smallest cellular organisms and are the most abundant in universe.

Structure:

- It is a rigid structure which is made of murein.
- It gives shape to bacteria and also protects of the cell from osmotic lysis.
- Unlike eu-karyotic organisms bacterial cell lack discrete chromo-some and nuclear membrane.



Bacteria have single, circular double stranded DNA

molecule.

- Bacteria contain 70S ribosome which is composed of RNA and proteins.

Sexual Reproduction in Bacteria:

- There is no actual sexual reproduction in bacteria because meiosis does not occur here also there is no formation of gametes occurs. However on the basis of exchange of genetic materials it occurs in three different ways.

(1) Conjugation: The process in which the DNA is transferred from one bacteria to another through conjugation tube.

(2) Transformation: In transformation one bacterium absorb the DNA of another bacterium.

(3) Transduction: In transduction the genetic materialare transferred from one bacterium to another bacterium through virus (bacteriophage).

Exercise

1. Which of the following is best suited stain in order to study chromosomes?
   a. Iodine solution b. Leishman's stain
   c. Feulgen's stain d. Aniline blue
2. The "Scavenger's or "Digestive bags" of a cell are……..
   a. Chromosomes b. Centrosomes
   c. Lysosomes d. Ribosomes
3. Following are the functions of cytoskeleton except:
   a. Maintaining cell shape
   b. Movement c. Contraction
   d. Respiration
4. Identify the mismatch in the following pairs?
   a. Mitochondria – cellular respiration
   b. Lysosome – intra cellular digestion
   c. Microfilament - cyclosis
   d. Glyoxisome – deamination
5. The most prominent cell organelle of a bacterial cell other than DNA is:
   a. Mesosome **b. Ribosome**
   c. Lysosomes d. Nucleosome
6. The cell wall of prokaryotic cell (bacterial) is composed of:
   a. Mesosome b. Lignin
   c. Cellulose **d. Murein**
7. The cell organelle in eukaryotic cell which is not bounded by the membrane is:
   a. Lysosome **b. Centriole**

c. Peroxisomes d. Mitochondrion

8. In which part of the chloroplast the fixation of CO_2 results in the formation of sugars?
   a. Envelope b. Stroma
   c. Thylakoid d. Intergranum

9. The organelle which is absent in animals cell:
   a. Plastids b. Centriole
   c. Lysome d. Nucleolus

10. The special proteins which carry lipid – insoluble large molecules through pores of plasma membrane are called:
   a. Permeases b. Catalases
   c. Arginases d. Amylases

11. The membrane enclosed spaces of endoplasmic reticulum are called:
   a. Lamellae **b. Cisternae**
   c. Stroma d. Cristae

12. All of the following refers to lysosomes except:
   a. Slightly larger than mitochondria
   b. Roughly spherical
   c. Single membrane bounded
   d. Contain powerful digestive enzymes

13. Lysosome are also called as:
   a. Peroxisomes b. Mesosomes
   c. Phagosomes d. Glyoxisomes

14. In the leaves of green plants, peroxisomes are the sites of:
   a. Respiration b. Photosynthesis
   c. Photorespiration d. Phototropism

Write short answers of the following questions.

Q1: List four main functions of nucleus.

Ans.

- It is regarded as the control room of the cell because it controls and manages all the activities of the cell.
- It is the site of heredity material in the form of DNA.
- It transfers the characters from parents to offsprings.
- It helps in cell division.

Q2: What do you know about peroxysome?

Ans. ***(Peroxi-peroxide, soma-body)***

Also called micro bodies.

Discovery:

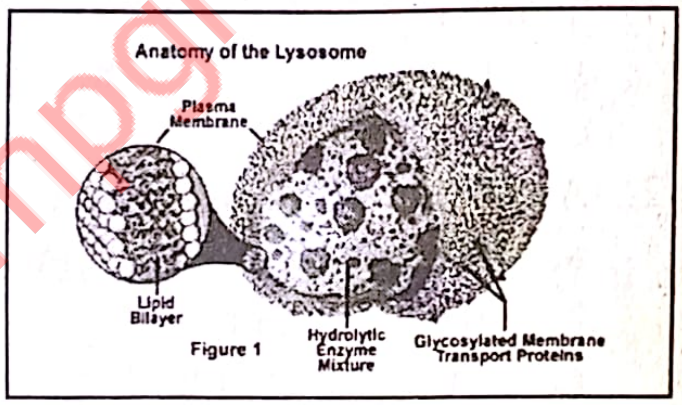


Figure 1

- C.De Duve and co-workers in 1996 in liver cells.
- It is a small organelle present in the cytoplasm of many cells.
- It is membrane bounded organelle.
- It contains enzymes that oxidize certain molecules normally found in the cell notability fatty acids and amino acids.
- Those oxidation reactions produces peroxides (H_2O_2) which is the basis of the name peroxysome.
- It contains catalyzes enzymes.

Size: It is about 0.5 μm in diameter.

Structure: It is rounded in structure.

Occurrence:

- It occurs in plants and animals cell.
- In plant cell it remains associated with endoplasmic reticulum. Chloroplast and mitochondria and are involved in photorespiration.
- In animal cells it is mostly occurs in liver and kidney.

Functions:

- In plants it is involved in photorespiration.
- They breakdown hydrogen peroxide (H_2O_2) into water and oxygen.
- They protect the cell from the corrosive effect of H_2O_2.

Destroy the toxic effect of alcohol.

Q3: What is the difference between rough and smooth endoplasmic reticulum?

Ans.

a. Ribosomes are present on the surface of rough endoplasmic reticulum while in case of smooth endoplasmic reticulum there are no ribosomes.

b. Rough endoplasmic reticulum is found abundantly in those cells which are active in protein synthesis such as pancreas cells. While smooth endoplasmic reticulum are mostly present in steroid producing cells such as interstitial cells and muscular cells.

Q4: What is cytoskeleton? Why it is consider to be important organelle in the cell?

Ans. a. Cytoskeleton: It was discovered by Koltzoff in 1928. It is a complex network of proteins filaments extended throughout the cytoplasm. It is spongy in nature and found in eukaryotic cells.

b. Cytoskeleton is consider an important organelle in the cell due to the following reasons:

(i) It plays an important role in muscle contraction.
(ii) It helps in movement of chromosomes in a cell.
(iii) It gives support and strength to the cell.
(iv) It is involved in the formation of endocytotic vesicles.
(v) It is involved in the formation of centriole, basal bodies, cilia and flagella.
(vi) It forms spindle fibers of the dividing cells.
(vii) It is the main shape and structure of a cell.

Q5: Cell is called structural and functional unit of life. Justify the statement.

Ans.

- Cell is called the structural and functional unit of life because the bodies of all living organisms are made of cells.
- Cell is called the structural unit because all structures of the body are made of cells.
- Cell is called the functional unit of life because all functions of the body are performed by cells.

Q6: Why are chloroplast found only in plant cells?

Ans. Chloroplast are found only in plant cells because they contain a green pigment chlorophyll. Chlorophyll traps sun light for photosynthesis.

Q7: What are the consequences of cell losing cell membrane?

Ans. Cell membrane is the outermost protective and semi permeable barrier of the cell. If it is intact and present around the cell, the cell will able to survive and if the cell membrane is lost or damaged the unnecessary and toxic material will enter the cell and useful orga-

nelles and molecules will come out of the cell consequently a cell will die.

Write the answer of the following questions:

Q1: Differentiate between prokaryotic and eukaryotic cell.

Ans. See text

Q2: Describe fluid mosaic mode of cell membrane.

Ans. See text

Q3: What do you known about Golgi apparatus? Discuss its functions.

Ans. See text

Q4: What are lysosomes? What role they play in a cell?

Ans. See text

Q5: Write a note on cytoskeleton.

Ans. See text

Q6: What do you mean by tissue culture? What are the main steps involved in tissue culture?

Ans. See text

Q7: How do cell organelles work together to keep us alive?

Ans. We know that cell is the basic unit of life. For a cell to perform its function at higher level, the cell itself needs to maintain itself alive.

For this the cell will get rid of a unwanted and toxic materials, produces essential proteins and have an energy providing system. Therefore the organelles should collectively keep the cell alive to function properly.

Q8: Discuss how the structure of specialized animal cell is related to their functions?

Ans.

- In animal cells are specialized for their function, and

because of this specialization cells are able to perform their functions properly which are assigned to them.

- Among trillion of cells for example humans have specification of cells to about 210 known type of cells.
- If a cell loses its structural relevance to its physiological function it will be unable to perform its function and hence will produces negative effects.
- For example human RBC are biconcave disc shape for better attachment of oxygen and easy flow through capillaries of its structure become sickle shaped then it will causes a disorder called sickle cell anemia.
- Similarly a nerve cell is designed for reception and transmission of impulse. Therefore it is having a specific structure composed dendrites and axon.
- The same structural and functional resemblance extends for muscle cells which are elongated cells and has the capacity of contraction and relaxation.
- The cells of skin are columnar or stratified in order to protect the skin from abrasion which is another example of structure to function specificity.